TP 6219 E

CN RAIL
EQUIPMENT DEPARTMENT
MOTIVE POWER

# LOCOMOTIVE EVENT RECORDERS - FIELD EVALUATION:

# PULSE MODEL 48H8-C-10

PREPARED FOR THE

**TRANSPORTATION DEVELOPMENT CENTRE**

**TRANSPORT CANADA**

CN RAIL - OPERATIONS
935 DE LA GAUCHETIERE ST. WEST
MONTREAL, QUEBEC
H3B 2M9
DECEMBER 1984

TP 6219 E

# LOCOMOTIVE EVENT RECORDERS - FIELD EVALUATION

## PULSE MODEL 48H8-C-10

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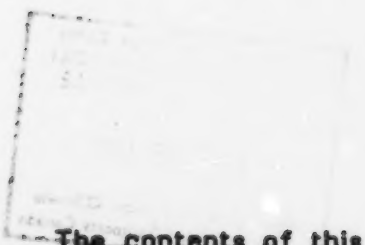

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17. Abstract

This report presents the results of a CN Rail field evaluation of ten Pulse Sentry II locomotive event recorders as a means to facilitate accident investigation (crash recorder) and improve the efficiency of train operation. This event recorder records the following eight events on a magnetic tape cassette: time (elapsed) speed, throttle level, brake pipe pressure, independent brake cylinder pressure, locomotive initiated emergency, whistle (horn) and distance. Once the tape cassette (data pack) is full, 48 to 52 hours of data, new data then overwrites the oldest on the tape. Recorder applications were made to ten locomotives during the period from June 1983 to November 1984 with no operational or maintenance problems being encountered during the evaluation period. One data pack failed to register on the playback unit after six months of service. The problem seemed to be in the data pack operating spool. The remaining data packs operated successfully in service for longer than the six month replacement interval recommended by the supplier.

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17. Résumé

Ce rapport par CN Rail présente les résultats d'une évaluation en service de 10 appareils enregistreurs Pulse Sentry II servant au contrôle des paramètres de fonctionnement des locomotives, dans l'optique des enquêtes entourant un accident, ou d'une meilleure efficacité de conduite des trains. Huit paramètres y sont enregistrés sur ruban magnétique: temps écoulé, vitesse, régime de marche, pression dans la conduite de freinage, pression dans le cylindre de frein, freinages d'urgence commandés à partir de la locomotive, signal sonore et distance. Lorsque la mémoire à ruban magnétique de l'appareil est épuisée (au bout de 48 à 52 heures), les nouvelles données remplacent les plus anciennes en les effaçant. Dix locomotives ont été équipées de ces appareils qui ont fonctionné entre juin 1983 et novembre 1984 sans aucun problème de marche ou d'entretien. Une seule mémoire a donné des ennuis de relecture au bout de six mois en service, le défaut étant localisé au niveau de la bobine. Toutes les autres mémoires ont bien fonctionné en service et ont même dépassé la limite opérationnelle de six mois préconisée par le fournisseur.

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## 1.0 INTRODUCTION

There is currently considerable interest in the application of Event Recorders to locomotives for both accident investigation and crew training. Given that there has been limited experience in Canada to date with Locomotive Event Recorders, this project was intended to assist in determining the required characteristics of Event Recorders and to provide an opportunity to all concerned to develop a management strategy to handle data. Also since little operating experience was available, the in-service test has provided a certain amount of reliability data which has been evaluated as part of the overall project.

## 1.1 OVERALL OBJECTIVE

To facilitate accident investigations through the use of Event Recorders and to permit improvements in productivity and efficiency of train operations.

## 1.2 PROJECT OBJECTIVES

To determine the operational suitability for accident investigation, through performance tests, and analysis of reliability and maintenance data of Locomotive Event Recorders that are potential candidates for installation on Canadian locomotives.

## 2.0 SYSTEM DESCRIPTION

## 2.1 DATA RECORDER - MODEL 48H8-C-10

The data Recorder mounted in the locomotive records the train operating parameters listed in Item 7.1.2e), and stores the data in a Data Pack (cassette), retaining the most recent 48 to 52 hours of information. The information to be recorded is transmitted from the locomotive wiring and a pneumatic manifold through multi-cable connectors to the recorder unit.

## 2.2 PNEUMATIC MANIFOLD

The purpose of a pneumatic (air) manifold, is to integrate into a single housing the pressure transducers and associated circuitry necessary to convert pneumatic measurements to electrical signals suitable for recording. Figures 7 and 8 show the installation of a Pneumatic Manifold under the cab floor of the locomotive.

## 2.3 DATA PACKS

Data Packs are magnetic tape cartridges used with recorders to store data. This is then transferred to paper charts for evaluation through a playback unit. Refer to Fig.5.

## 2.4 PLAYBACK UNIT

The playback system is used to record on a paper chart the data stored in the Data Packs. The system used during test period is a Deck-Top model and is shown in Fig.5.

The operating features of system are listed below:

2.4.1 The POWER ON switch controls the electric power to all modules within the play back system. The power source is a 120 Volt A.C. outlet.

2.4.2 The DISPLAY rotary switch has 4 positions (STOP, COMPRESSED, NORMAL and EXPANDED) to control the speed of the stripchart and the resolution of the distance and time marks.

In the NORMAL position, marks corresponding to 1-mile, 10-mile and 100-mile increments are superimposed on the speed trace. Elapsed hour and minute marks are available for display.

In the EXPANDED position, the stripchart is expanded to 5 times the normal presentation, and 1/4-mile marks are added. Refer to Fig.4A as example of Expanded data output.

In the COMPRESSED position, the stripchart is compressed to 1/5 the normal presentation. Only 10-mile and 100-mile marks are superimposed on the speed trace. Elapsed hours are available for display.

2.4.3 The WHEEL SIZE switches are used to scale distance and speed information in proportion to the size of the wheel coupled to the axle generator. Wheel size is measured and recorded at removal of Data Pack from recorder.

2.4.4 The Playback unit has the capability to duplicate Data Pack. There are two main reason to duplicate the information stored and magnetic tape. First, as a back-up in case the original Data Pack is lost or destroyed. Secondly, to edit (copy segments rather than entire tape) from one or several Data Packs. As shown in Fig. 5 the top slot is for the insertion of the MASTER Data Pack (tape to be duplicated) and the bottom slot for the insertion of DUPLICATE blank Data Pack.

## 2.5 RECORDER VERIFIER

A test connector is located on the recorder's inside panel. It is located where the Test L.E.D. is found on other models (see Fig.1). An external recorder verifier (see Fig.2) can be connected to the test plug to verify operation of the entire system.

## 3.0 WORK PERFORMED

### 3.1 WORK ACCOMPLISHED

#### 3.1.1 Equipment Department Personnel - Headquarters

- W. L. Draper - Assistant Chief - M.P.
- C. R. Battley - Manager, MP Maintenance, MP
- R. J. Lusk - System Mechanical Officer, MP
- J. R. Lauzon - Technical Officer - Electrical
- L. White - Special Electrical Assistant

Equipment Department Personnel - Regional

Prairie Region

- R. J. Cordner - Sr. Mechanical Assistant - Region

Great Lakes Region

- W. Carswel - Mechanical Assistant - Region
- G. Shepardson - Foreman Electrical - MacMillan Yard

St.Lawrence Region

- P. Bourgoin - Mechanical Assistant - Region
- P. Gerber - Search Supervisor - Taschereau Yard

Transportation Department

- R. C. Field - Manager Development - Planning
- L. G. Finnerty - System Master Mechanic - Operations

CN Rail Research Center

- D. F. Lawless - Sr. Engineering Asst.-Eng.Research

#### 3.1.2 Recorder Applications

a) First installation applied to St. Lawrence Region, Taschereau Yard, assigned unit 9406 on 15 June 1983.

b) Remaining recorders were received on 16 August, 1983, and were distributed as follows to application locations.

2 - Taschereau Yard - St. Lawrence Region - Montreal
4 - MacMillan Yard - Great Lakes Region - Toronto
3 - Symington Yard - Prairie Region - Winnipeg
1 - Transport Canada (Delivered 09/07/83).

c) Application of Pulse Recorder including 9406 as per (a) is as follows:

1 - Taschereau Yard, St. Lawrence Region, Montreal. Quebec, applied to:

9406 - 15 June 1983
9621 - 6 October 1983
9622 - 26 September 1983

2 - MacMillan Yard - Great Lakes Region, Toronto. Ontario, applied to:

9512
- 7 October 1983
9513
- 8 October 1983
9515
- 3 November 1983

3 - Symington Yard - Prairie Region, Winnipeg, Manitoba, applied to:

9466*
- 8 November 1983
9488
- 21 October 1983
9492
- 9 November 1983

*Transferred to Taschereau Yard first week of January 1984.

d) Pulse recorder "Verifiers" were received by Winnipeg and Toronto during the week of 2 January 1984, in addition to one received in Montreal, June 1983 for the initial application to unit 9406.

e) Play Back unit for Data Packs was received on September 6, 1984, and is now located in Headquarters Equipment Department.

f) The Data Packs were removed from units in two (2) stages -

1 Stage: To qualify the operation of recorder by transferring the recorded information from Play Back unit to paper charts.

2 Stage: To evaluate the life expectancy of Data Pack (minimum 6 months from supplier) with the use of Play Back unit.

The information recorded is as follows:

| Unit No. | No.1 Applied | No.1 Removal | No.2 Applied | No.2 Removal | Last Appl. |
|---|---|---|---|---|---|
| 9621 | 06-10-83 | 14-12-83 | 19-12-83 | 19-09-84 | 28-09-84 |
| 9622 | 26-10-83 | 18-12-83 | 19-12-83 | 04-10-84 | 15-10-84 |
| 9406 | 15-06-83 | 07-10-83 | 10-10-83 | 16-09-84 | 28-09-84 |
| 9512 | 07-10-83 | 12-12-83 | 20-12-83 | 26-09-84 | 29-09-84 |
| 9466 | 08-11-83 | 02-02-84 | 10-02-84 | 05-11-84 | 20-11-84 |
| 9488 | 21-10-83 | 05-03-84 | 23-03-84 | 23-09-84 | 28-11-84 |
| 9492 | 09-11-83 | 15-03-84 | 10-04-84 | 21-09-84 | 29-09-84 |
| 9513 | 08-10-83 | 14-12-84 | 20-12-84 | 24-09-84 | 28-09-84 |
| 9514 | 03-10-83 | 12-12-83 | 07-02-84 | 03-09-84 | 19-09-84 |
| 9515 | 03-11-83 | 14-12-84 | 30-09-84* | | |

*Found tape missing 30 September 1984. New tape applied. Charts are available at CN H.Q. Equipment Department.

g) All applications completed as of 9th November 1983 (100% complete).

h) The following is an assessment of various performance parameters of Pulse Event Recorder.

I) The recorder is equipped with a hasp for the application of a seal or padlock to prevent tampering with the Data Pack.

The electric cables that plug into recorder are too accessible, and can be removed at anytime, when the plug(s) are removed from recorder, the memory module (Data Pack) will stop recording, and will only be re-activated when plug(s) are re-applied to the recorder. Some form of locking device will be required in order to prevent tampering with control cables.

II) The personnel responsible for Data Pack recovery is to be the Transportation Officer at the scene of accident.

III) The life expectancy of the recorded information on Data Pack is indefinite.

IV) An information and identification tag is applied to the Data Pack every time same is applied to recorder. The information requested to be written on the label at removal of Data Pack includes locomotive road number, recorder serial number, installation date and location, removal date and location, train number and time, wheel size at removal.

V) The event recorder records the required eight (8) events as stipulated in Item 4.4 of contract. The events are:

1. Time.
2. Speed.
3. Throttle level.
4. Brake pipe pressure.
5. Independent brake cylinder pressure.
6. Locomotive initiated emergency.
7. Whistle (Horn).
8. Distance.

It has been noticed that the recording of the whistle (Horn) event on Data Pack recording charts is shown in most instances, as a small dot. This is very hard to read. It is suggested that by reducing the pick-up setting of the corresponding pressure switch located in the pneumatic (air) manifold control box, the identification of a whistle (horn) event would extend from a dot to a dash on recording charts and thus be more readily discernible.

VI) The recording capability of Data Pack is from 48 to 52 hours.

VII) Once the memory (Data Pack) is full, new data overwrites the oldest data in the memory (Data Pack).

VIII) Time to fill memory (Data Pack) is 48 to 52 hours, with distance being relevant to train operation during Data Pack time cycle.

IX) It is possible to distinguish the latest data entry in Data Pack from oldest entry, as the Play Back system writes an end of tape mark on Data Pack when the Reset/Operate switch on the Play Back unit is depressed.

3.1.3 Accident Simulation Test

a) Accident simulation tests were performed on the 7th February 1984, on recorder equipped unit 9514 in a consist with CN R&D Test Car. Test runs were performed at various speeds to simulate a crossing accident.

b) The calibrated independent recording system of the CN R&D Test Car was used for comparison purposes and as a means to assess the performance of the event recorder on unit 9514.

c) The maximum number of recorded events was varied during each run, including speed, throttle level, brake, horn.

d) Both event recording systems (9514 and R&D Test Car) were activated to record the events during each run.

e) Both strip chart data from unit 9514 and R&D Test car were analysed and they compared favourably.

Test run was made between Montreal and Rouse Point, the 7th of February 1984. Section of both strip charts were taken between mileage 11 and 13, and are shown in Fig.4 for test car and Fig.4A (see naotes on figures 4 and 4A) for unit 9514 to illustrate a P.C. (Deadman) initiation.

When comparing both charts, the following should be taken into consideration.

1. The ELAPSED TIME MARKS on the R&D chart are in 1 second/Division, while on the Pulse chart they are in 1 minute/Division.

2. P.C. (Deadman) - In Section 5 on the R&D chart, the magnet valve operation is shown as a voltage drop (de-energized), while on the Pulse chart it is shown as P.C.S. open.

3. When comparing the Horn operation between both charts, it should be noted that the recording on the Pulse chart is more difficult to analyse with relation to time due to the ELAPSED TIME MARKS being at 1 minute intervalswhich corresponds to approximately 7/16" (1 cm).

### 3.1.4 Reliability Maintenance Evaluation

The ten (10) Pulse Event Recorders have been in service for periods exceeding one (1) year and have proven to be reliable as confirmed by data listed in Item 3.1.2 (f) of this report.

Since the initial installations of recorders to locomotives no maintenance problems have been brought to our attention.

The general crew reaction would seem favourable as no verbal or written objections were received during the evaluation period.

### 3.1.5 Problem Areas

The integrity of all listed installations have been completed with the use of "Verifier" with no problems reported during the evaluation period.

## 4.0 TEST RESULTS

4.1 Ten (10) Pulse Locomotive Event Recorders have been installed on ten (10) CN locomotives and have been running for over one year without having to be serviced.

The supplier recommends that data packs (recording unit) be changed out and discarded at six months intervals. The test results have indicated that Data Packs are still operational beyond the recommended change out period.

## 5.0 RECOMMENDATIONS

5.1 Several design features were noticed during the test period of Pulse Event Recorders.

It should be noted that the design changes are for future reference and discussion.

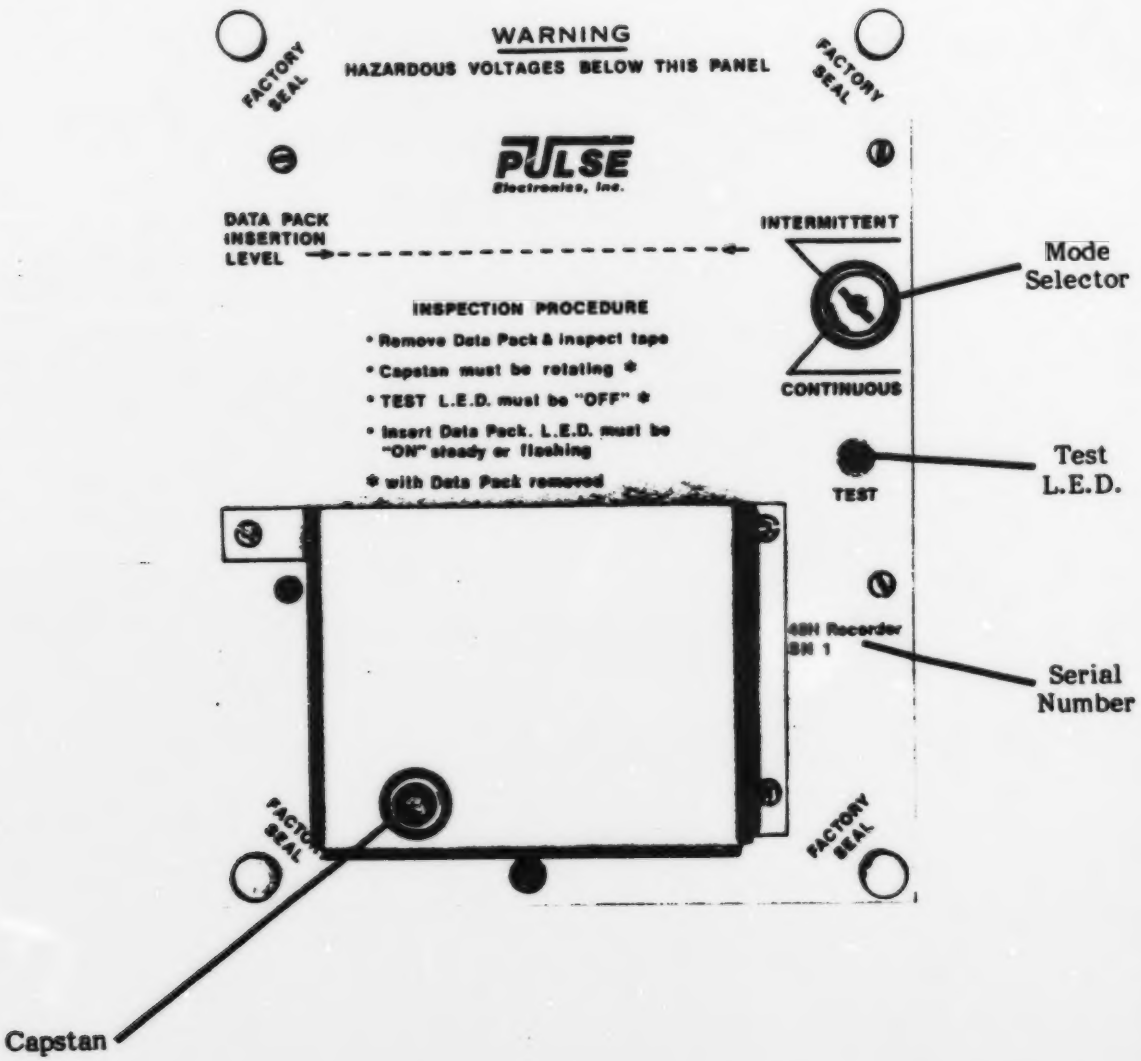
1. The supplier states that the data pack (cassette) must be mounted horizontally. This stipulation requires that the recorder box must be floor on otherwise mounted in such a way as to form a shelf or table. It would facilitate installation if the data pack were inserted in a box similar to automobile cassette players. This would allow for wall mounting of the recorder box thus increasing the choice of areas on a locomotive where installation would be possible.

2. A self-test feature is not available on the Pulse Recorder. At present, a remote verifier which plugs into recorder, is required to ensure that all input signals are functioning properly.

   A self-test should be built into each recorder so as to allow personnel at all maintenance points (shops) to verify, at any time, the operation of all input signals.

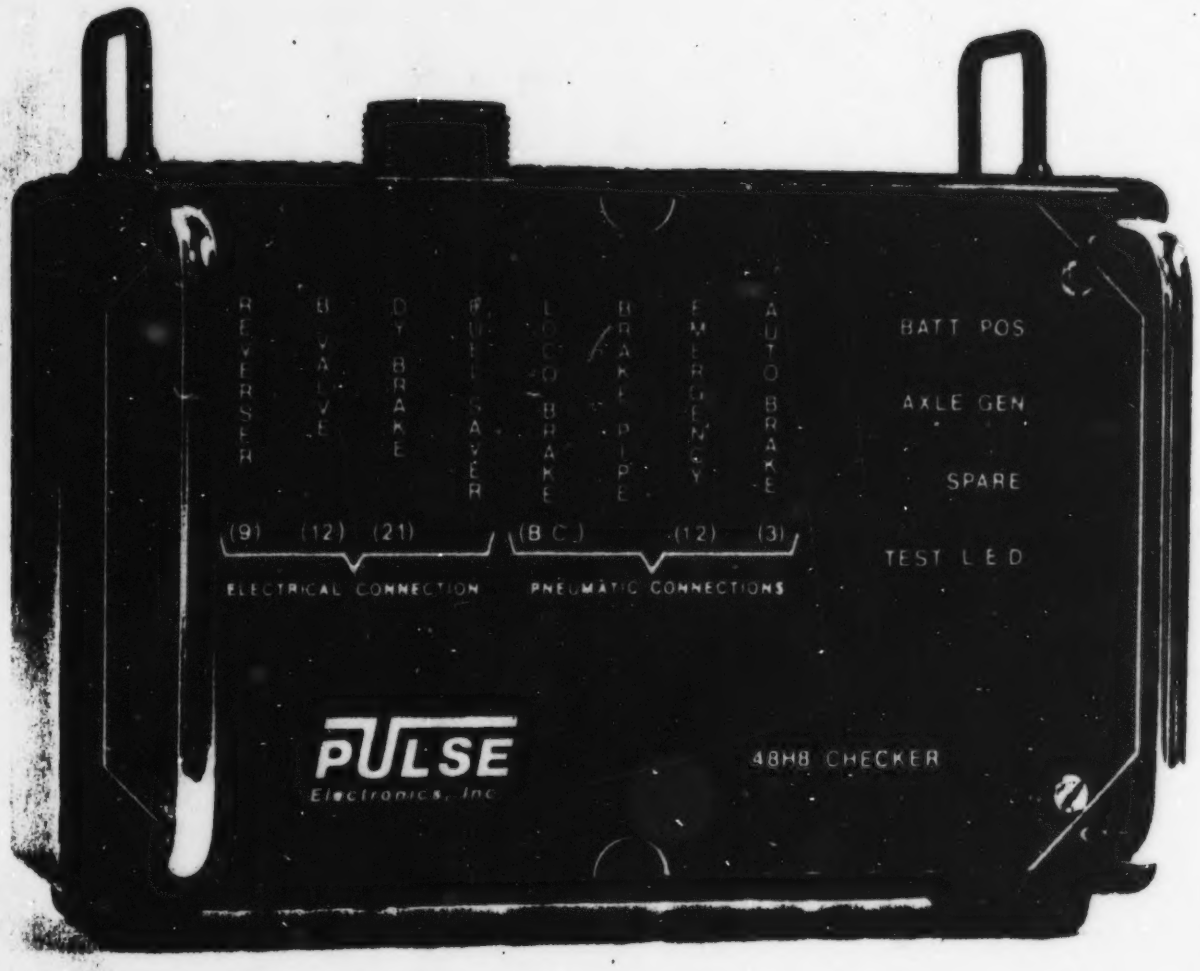
3. Pressure switches and transducers could be separate units, and not as presently mounted in a single Pneumatic Manifold. Individual switches and transducers could then be located in the air lines accessible in the control stand, thus eliminating the extensive underfloor piping required for the present applications. It would also eliminate one electrical harness (from pneumatic manifold to recorder box). One main elecrical harness would then be possible from recorder box to control stand.

4. For detailed examination of recorded data on strip charts, much more expanded scale would be useful.




RECORDER'S INSIDE PANEL

FIGURE 1



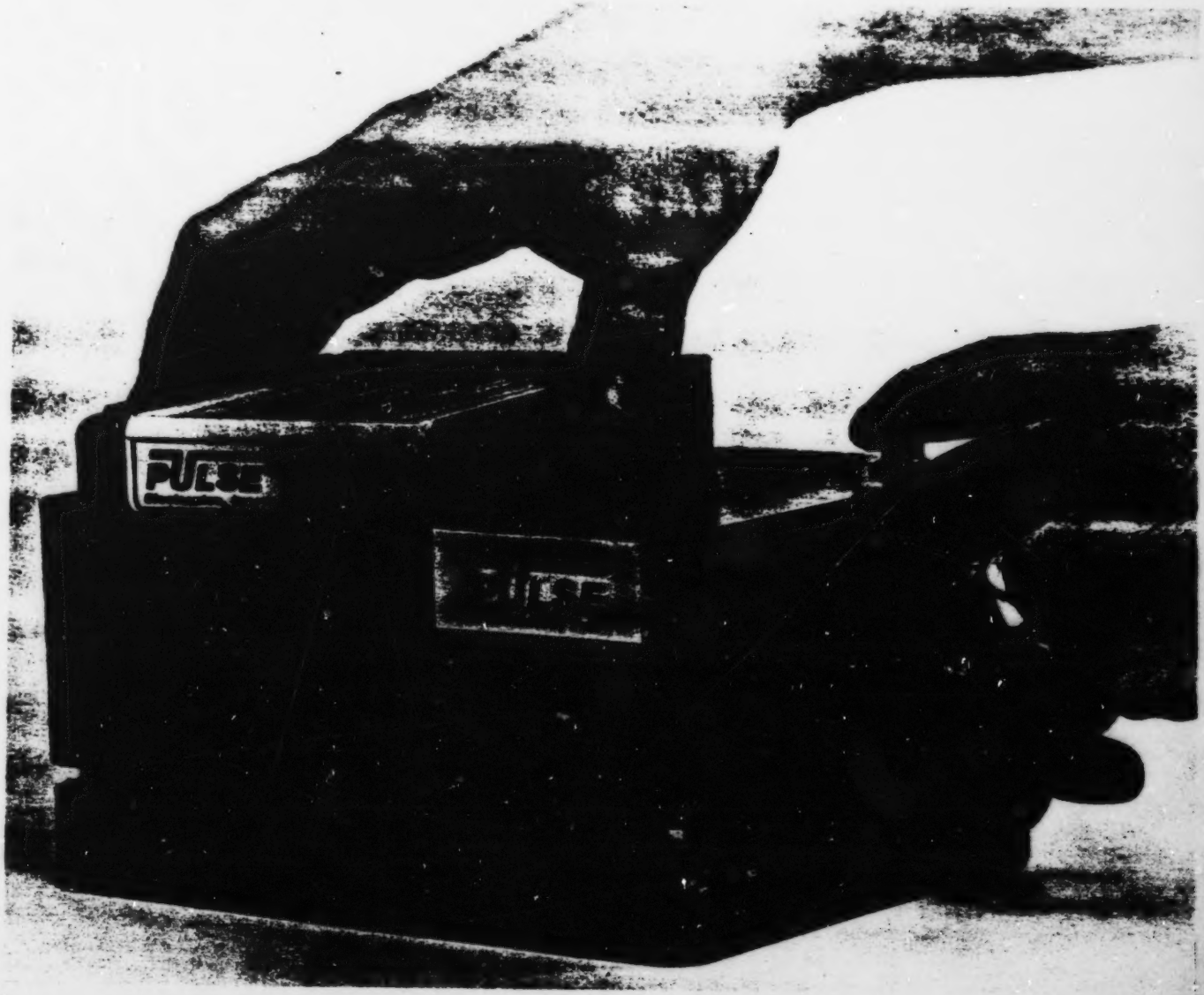

**RECORDER VERIFIER**

**Figure 2**

ERASE PROCEDURE

To electrically erase a Data Pack place it over a PULSE magnetic tape eraser (or one approved by PULSE), and move it slowly over the eraser's surface for 20 seconds. Then, turn the Data Pack over and repeat the procedure for another 20 seconds (see figure 3).

Since an accidental partial erasure might occur, do not keep Data Packs to be preserved in close proximity to the eraser.




**DATA PACK ERASER**

**Figure 3**

ACCUGRAPH® Gould Inc. Cleveland, Ohio Printed in U.S.A.

8:45

ACCUCHART® Gould Inc. Cleveland, Ohio Printed in U.S.A.

8:45

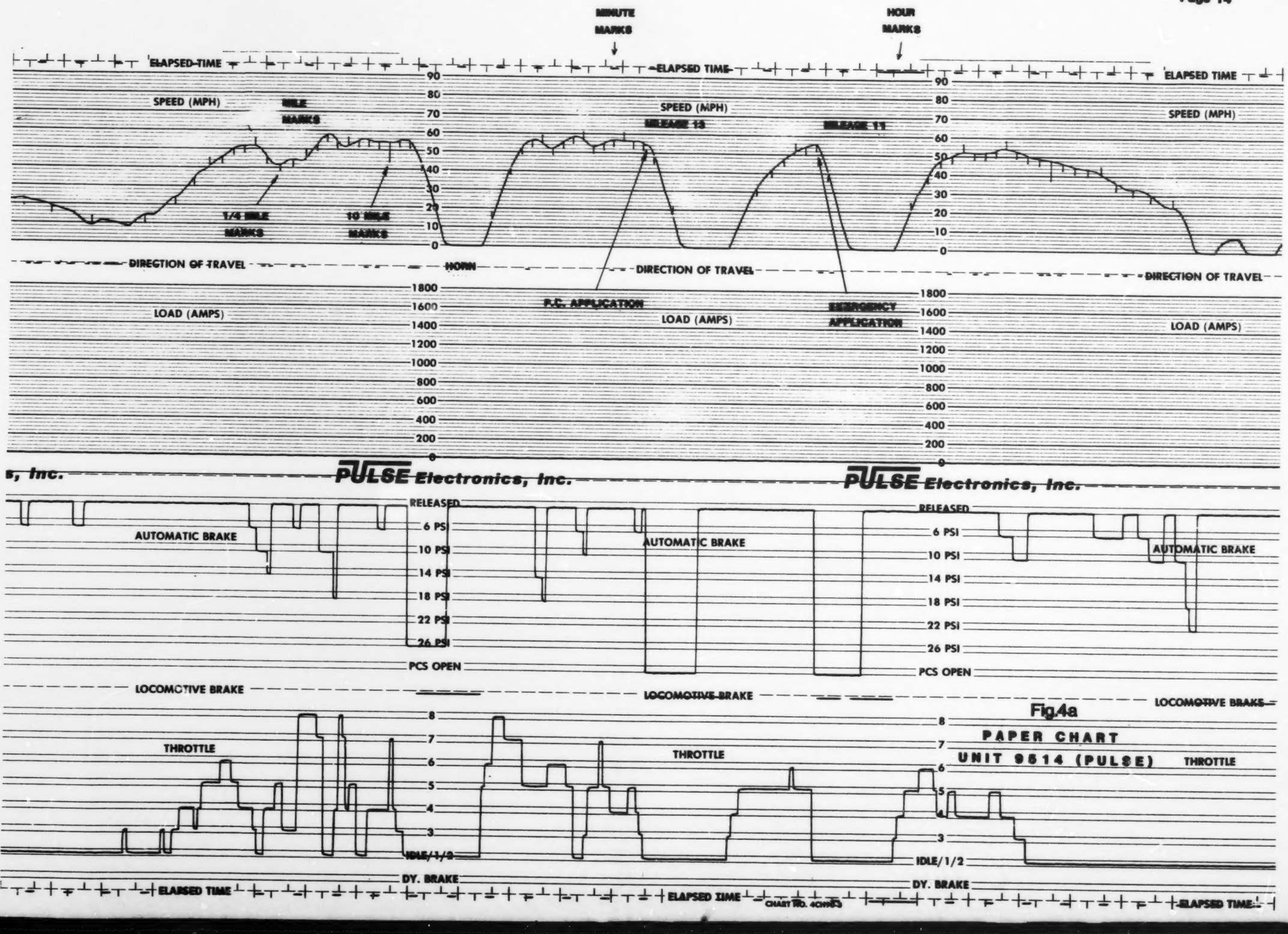
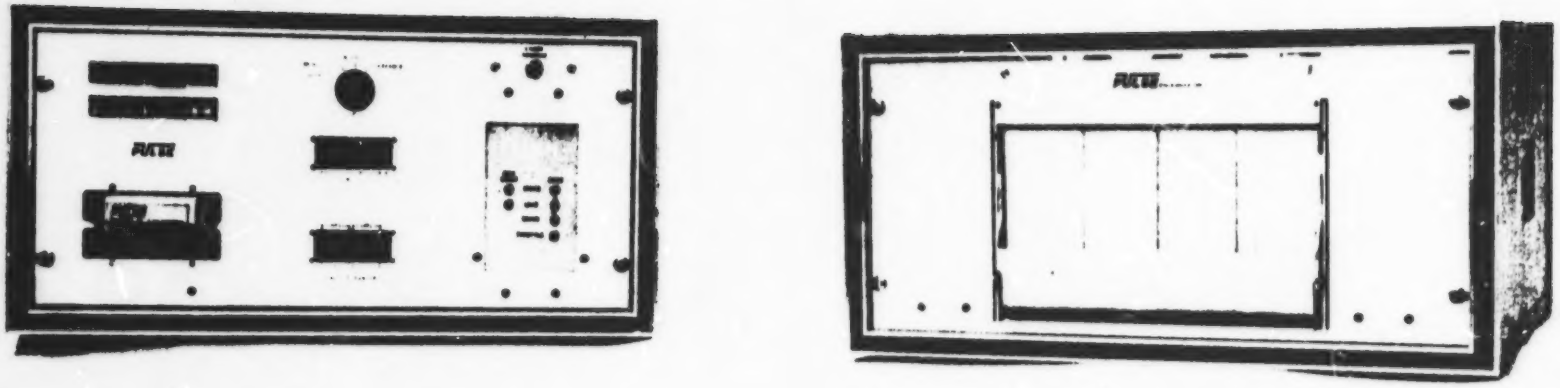



Fig.4a

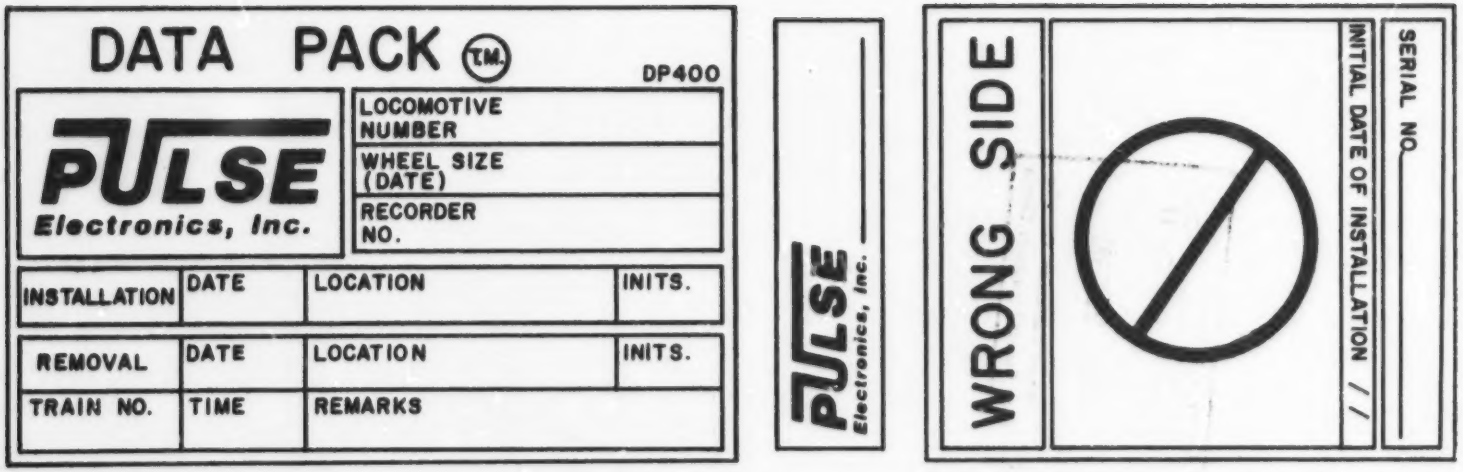
PAPER CHART

UNIT 9514 (PULSE)



DESK-TOP PLAYBACK SYSTEM

Figure 5




**DATA PACK IDENTIFICATION LABEL**

**Fig.6**